Flipping the Physics Classroom

A working group

UPPSALA UNIVERSITET

Ali Al-Adili, Erik Andersson Sundén, Agnese Bissi, Li Caldeira Balkeståhl, **Marco Chiodaroli**, Rikard Enberg, **Lisa Freyhult**, Virginia Grande, Sophie Grape, Cecilia Gustavsson, **Katerina Günter**, Tomas Kubart, **Magdalena Larfors**, Arne Sahlberg, Karin Schönning, **Andreas Solders**, Diego Tarrío, and Erik Zackrisson

Overview

The flipped-classroom model has recently attracted considerable attention in higher-education research. In the Department of Physics and Astronomy at Uppsala University, several courses have introduced flipped components. However, such implementations have been mostly enacted on a case-by-case basis with comparatively little coordination among different instructors. This poster reports on the activities of a recently-created working group within the Physics and Astronomy department. The group aims at assisting, promoting and coordinating implementation of flipped pedagogical methods in individual courses and is supported by TUFF funding. Part of our goal is to assess the impact of flipped classrooms on student learning gains, attitudes, and preferences with a mixed-method pilot study.

Introduction

The flipped classroom is an instructional design in which "activities that have traditionally taken place inside the classroom now take place outside of the classroom and vice versa" [1]. The central idea of this approach is to replace traditional lecturing with structured at-home activities, typically involving videos or other learning technologies, and to use class time for hands-on exercises and other active-learning activities [1, 2, 3]. Advocates regard inverting the classroom as a mean to promote active learning while balancing time constraints and the need to cover sufficient content. Despite evidence in favor of the flipped-classroom approach from studies of student attitudes and evaluations, research has been thus far inconclusive with regard to learning gains, with mixed results reported in the literature (see for example [4, 5, 6]).

While in recent years a flipped-classroom component has been introduced in several Physics and Astronomy courses offered at Uppsala University, systematic coordination between different courses has been missing. Our working group involves 18 core participants and is aimed at overcoming this gap.

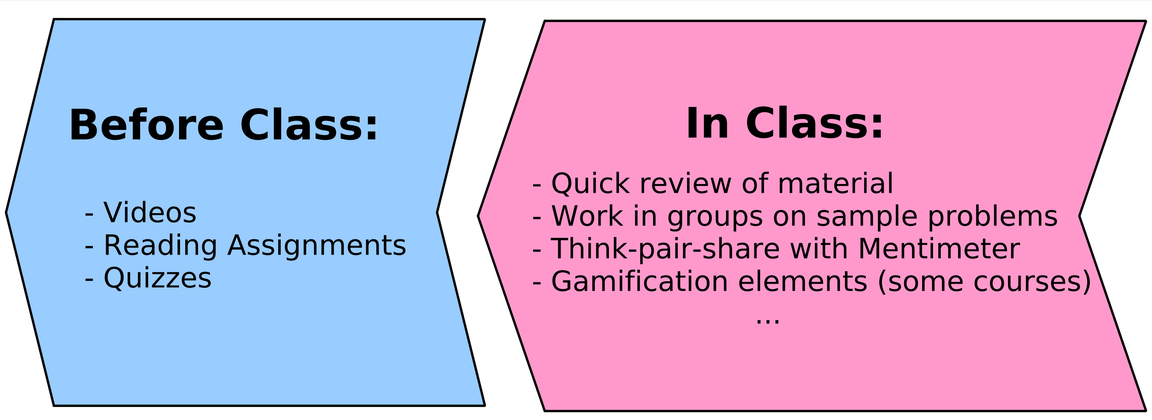

Figure 1: Instructional model employed. Activities vary based on individual courses

Implementation Strategy

The group's activities are structured as follows:

1. A flipped component will be introduced in seven courses, listed in Table 1. Each course involved will flip at least one module corresponding to 2-3 individual lectures. As a direct result of the project, **approximately 350 students will experience some form of flipped classroom**.
2. Following research, our **flipped-classroom design** will divide instruction into four distinct structured phases: (1) pre-class information gathering, (2) preliminary assessment quiz, (3) in-class active learning, and (4) evaluation (e.g. final exam). See Figure 1.
3. Regular **workshop meetings** help coordinate implementation and assist creation of instructional material. Meetings are open to everybody in the department who is willing to attend.
4. Educational material created as a result of our project is shared among participants and with other instructors. By the end of the year a **resource library** will be created which will include videos, quizzes, worksheets and other material for in-class activities. This will be a useful resource for instructors planning to incorporate flipped classrooms in their teaching.

Course	N	
Gravitation and Cosmology (1FA157)	20	Spring
Nuclear Physics (1FA346)	60	Fall
Quantum Mechanics, Advanced Course (1FA352)	50	Fall
Mathematical Methods (1FA121)	80	Spring
Dynamical Systems and Chaos (1FA152)	40	Spring
Searching for extraterrestrial intelligence (1FA217)	80	Fall
Quantum physics (1FA521)	30	Spring

Table 1: Specific courses involved; N = approx. number of students.

Evaluation

A pilot study will be conducted on the impact of flipped methods on students' attitudes and educational gains. Specific research questions with preliminary methodologies include:

- **Can we observe learning gains** with respect to traditional lecturing? ← *Final-exam comparison with previous years*
- **How do students allocate time** in response to the new instructional format? ← *Weekly questionnaires on time allocation*
- **Are students engaged at a higher cognitive level**? *Comparison of performances in concept inventory tests between flipped and traditional portions of several courses*
- **How do expectations from instructors compare with students' experiences**? ← *Focus group*

Each part of the evaluation will involve a subset of the courses in Table 1.

Moving forward

Our project addresses in a coordinated fashion educational improvements which have been so far conducted at the level of individual courses, with an eye towards physics education research. Our activities will result in the creation of resources which can facilitate the work of other instructors interested in flipped classrooms, while our evaluation strategy focuses on methodologies that can be scaled up during a second year and extended to multiple courses. By the end of the year, we intend on having a clear research design for a publishable study. Using data from the pilot, funding for conducting the study will then be pursued.

Acknowledgments and references

We gratefully acknowledge funding from the Teknisk-naturvetenskapliga fakultetens universitetspedagogiska förnyelsefond (TUFF) to support the group's activities during the 2019 calendar year.

[1] Lage, M., Platt, G., Treglia, M. (2000), The Journal of Economic Education, 31(1), 30-43. doi:10.2307/1183338

[2] Bishop, J. L., Verleger, M. A. (2013), In ASEE National Conference Proceedings, Atlanta, 30(9), 1-18.

[3] O'Flaherty, J., Phillips, C. (2015), The Internet and Higher Education, Volume 25, 85-95.

[4] Love, B., Hodge, A., Grandgenett, N., Swift, A. (2014), International Journal of Mathematical Education in Science and Technology, 45(3), 317-324. doi:10.1080/0020739X.2013.822582

[5] Jensen, J., Kummer, T., Godoy, P. (2015), CBE-Life Sciences Education. doi:10.1187/10.1187/cbe.14-08-0129

[6] Ojennus, D. (2015), Biochemistry and Molecular Biology Education, 44(1) 20-27. doi:10.1002/bmb.20926